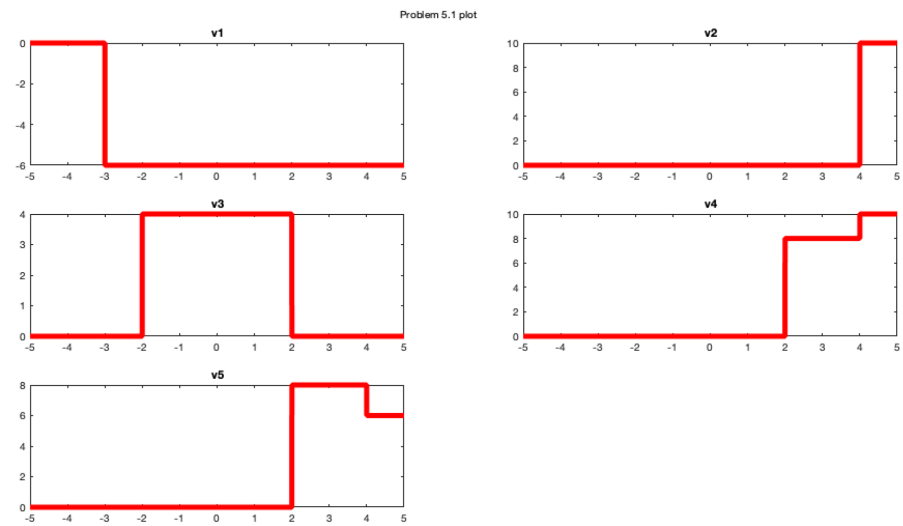
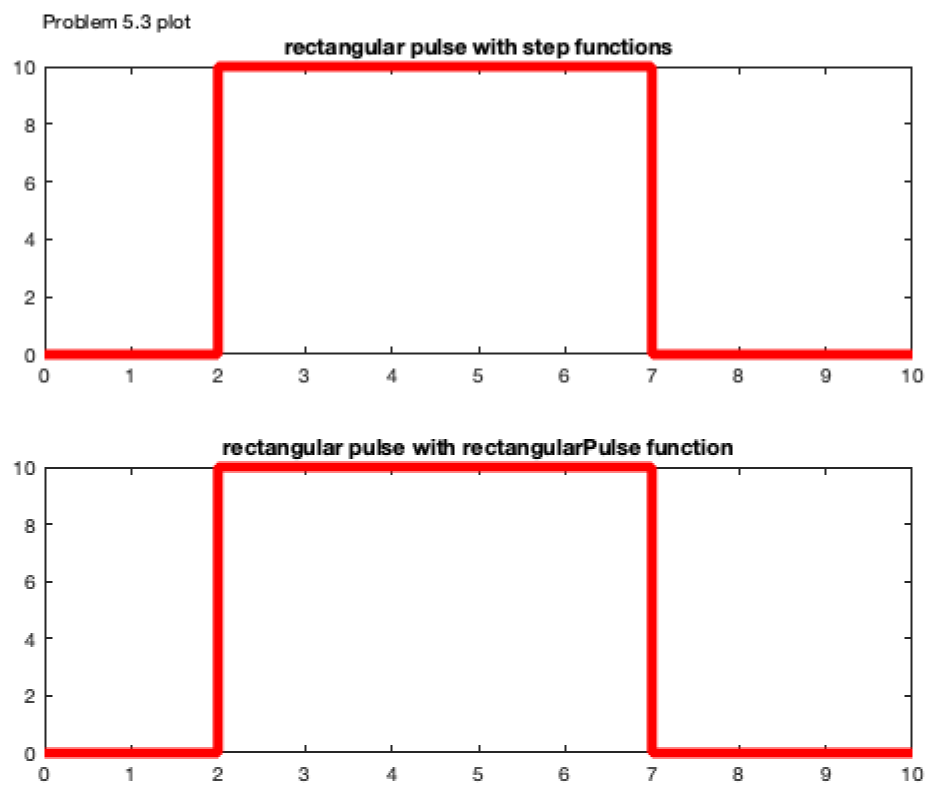
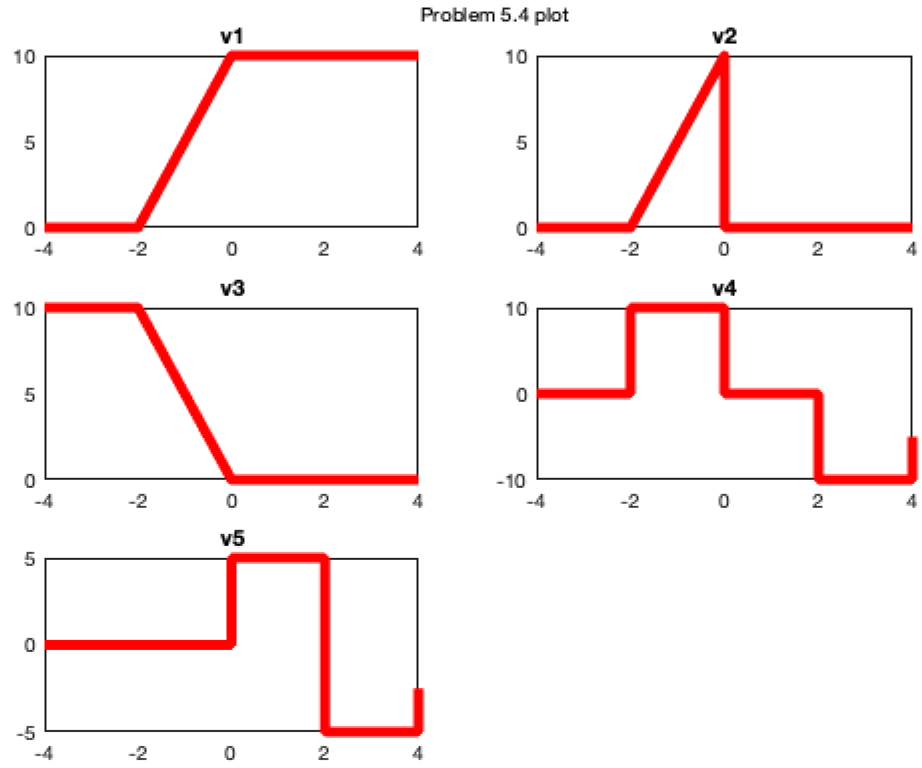
```
clear all; close all;
syms x
% For this problem, we will use a heaviside function in Matlab to
 generate
% the plot. A heaviside function is used to generate a standard unit
 step
% function, which has a output of 1 when input is greater equal than 0
 and
% output of 0 when input is less than 0.
% For more information, you can type 'help heaviside' in the command
 window
% of Matlab to learn further.
% We will also use rectangularPulse(a, b, x) to generate rect wave,
 where
% a means the rising edge of rect pulse and b means the falling edge
 of
% rect pulse
%---------------Problem 5.1---------------


v11 = -6*heaviside(x+3); % expression for v1(t)
v12 = 10*heaviside(x-4); % expression for v2(t)
v13 = 4*heaviside(x+2) - 4*heaviside(x-2); % expression for v3(t)
v14 = 8*heaviside(x-2) + 2*heaviside(x-4); % expression for v4(t)
v15 = 8*heaviside(x-2) - 2*heaviside(x-4); % expression for v5(t)

figure(1)
subplot(3,2,1)
fplot(v11,[-5, 5],'red','LineWidth',5);
title('v1')
subplot(3,2,2)
fplot(v12,[-5, 5],'red','LineWidth',5);
title('v2')
subplot(3,2,3)
fplot(v13,[-5, 5],'red','LineWidth',5);
title('v3')
subplot(3,2,4)
fplot(v14,[-5, 5],'red','LineWidth',5);
title('v4')
subplot(3,2,5)
fplot(v15,[-5, 5],'red','LineWidth',5);
title('v5')

gtext('Problem 5.1 plot')

%---------------Problem 5.3---------------
% The unit-step expression can be found in the Appendix G of textbook.
% In order to simplify for programming, we use 2 and 7 to replace
 2micro
% and 7micro.
v31 =  10*heaviside(x-2) - 10*heaviside(x-7);
v32 = 10*rectangularPulse(2,7,x);
```

```
figure(2)
subplot(2,1,1)
fplot(v31,[0, 10],'red','LineWidth',5);
title('rectangular pulse with step functions')
subplot(2,1,2)
fplot(v32,[0, 10],'red','LineWidth',5);
title('rectangular pulse with rectangularPulse function')
gtext('Problem 5.3 plot')
% As you can seen in both plots in figure 2, a 10V rectangular pulse
 with
% width 5 and starting at 2 is generated.

%---------------Problem 5.4---------------
v41 = 5*(x+2)*heaviside(x+2) - 5*(x)*heaviside(x);
v42 = 5*(x+2)*heaviside(x+2) - 5*(x)*heaviside(x) - 10*heaviside(x);
v43 = 10 - 5*(x+2)*heaviside(x+2) + 5*(x)*heaviside(x);
v44 = 10 * rectangularPulse(-2,0,x) - 10 * rectangularPulse(2,4,x);
v45 =  5 * rectangularPulse(0,2,x) - 5 * rectangularPulse(2,4,x);

figure(3)
subplot(3,2,1)
fplot(v41,[-4, 4],'red','LineWidth',5);
title('v1')
subplot(3,2,2)
fplot(v42,[-4, 4],'red','LineWidth',5);
title('v2')
subplot(3,2,3)
fplot(v43,[-4, 4],'red','LineWidth',5);
title('v3')
subplot(3,2,4)
fplot(v44,[-4, 4],'red','LineWidth',5);
title('v4')
subplot(3,2,5)
fplot(v45,[-4, 4],'red','LineWidth',5);
title('v5')
gtext('Problem 5.4 plot')

% v11 = @(x) -6*heaviside(x+3); % expression for v1(t)
% v12 = @(x) 10*heaviside(x-4); % expression for v2(t)
% v13 = @(x) 4*heaviside(x+2) - 4*heaviside(x-2); % expression for
 v3(t)
% v14 = @(x) 8*heaviside(x-2) + 2*heaviside(x-4); % expression for
 v4(t)
% v15 = @(x) 8*heaviside(x-2) - 2*heaviside(x-4); % expression for
 v5(t)
% xticks = -5:.01:5;
% plot( xticks,  feval(v11, xticks), 'red','LineWidth',5 );
% plot( xticks,  feval(v12, xticks), 'red','LineWidth',5 );
% plot( xticks,  feval(v13, xticks), 'red','LineWidth',5 );
% plot( xticks,  feval(v14, xticks), 'red','LineWidth',5 );
% plot( xticks,  feval(v15, xticks), 'red','LineWidth',5 );

% fplot((x+2)*heaviside(x+3),[-5, 5],'red','LineWidth',5)
```

```
% fplot((x+2)*heaviside(x+2),[-5, 5],'red','LineWidth',5)
% fplot(rectangularPulse(-2,-3,x),[-5, 5],'red','LineWidth',5)
```







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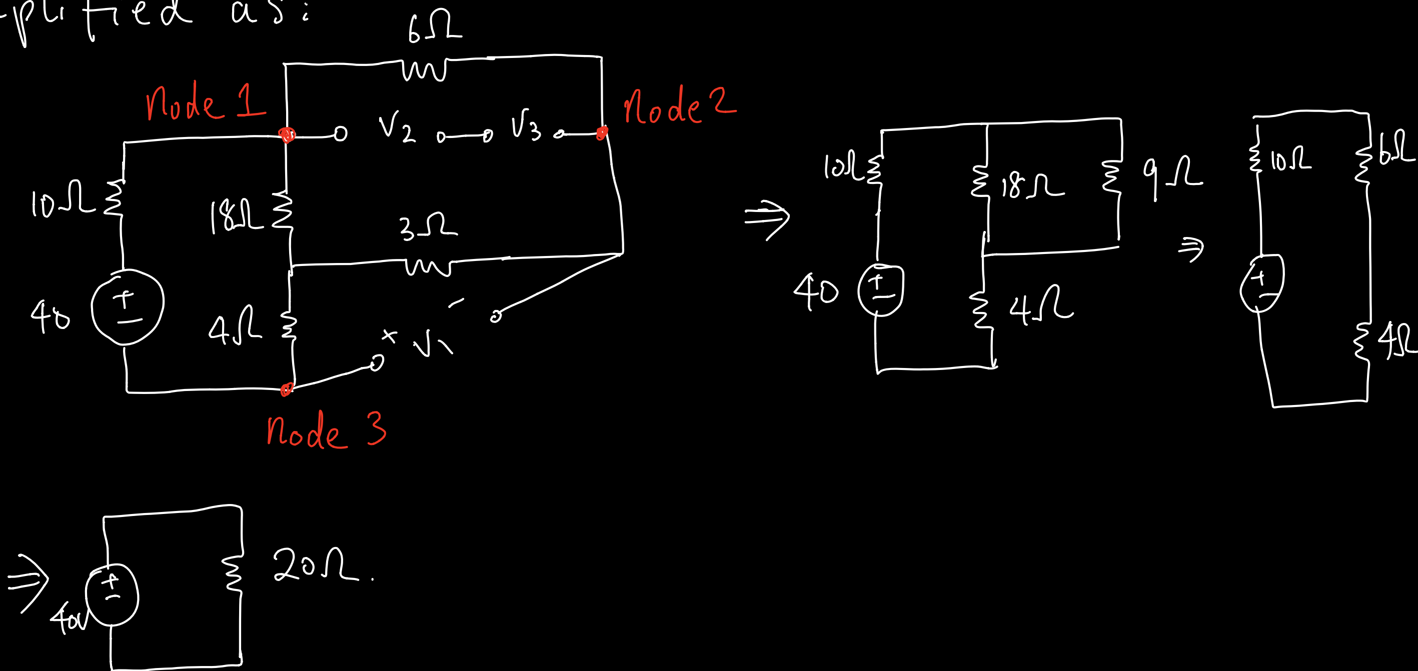
Since the only source is a dc souce, there will be no voltage change across capacitor. That being said, we can treat the branch with capacitor as open circuit. As a result, our circuit can be simplified as:



As a result, the voltage across node 1 and node 2 is:

$$40 \times \frac{6}{20} \times \frac{6}{9} = 8V$$

According to the voltage division for capacitor:

$$V_2 = 8 \times \frac{60\mu}{20\mu + 60\mu} = 6V$$

$$V_3 = 8 \times \frac{20\mu}{20\mu + 60\mu} = 2V$$

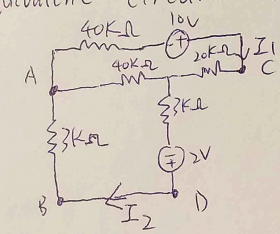
Voltage across node 3 and node 2 is

$$V_1 = -\left(40 \times \frac{4}{20} + 12 \times \frac{3}{9}\right) = -12V$$

5.16

Since ~~It is~~ the circuit is under dc conditions.

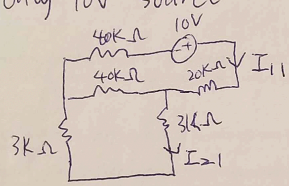
Equivalent circuit as below



$\Rightarrow$ $V_1 = V_A - V_B$ (because no current passing that 10kΩ resistor)

$V_2 = V_C - V_D$

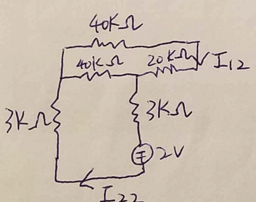
① only 10V source



$$I_{11} = \frac{10V}{20k\Omega + (40k\Omega \,||\, 6k\Omega) + 40k\Omega} = \frac{23}{150}\text{ mA}$$

$$I_{21} = I_{11} \times \frac{40k\Omega}{40k\Omega + 6k\Omega} = \frac{2}{15}\text{ mA}$$

② only 2V Source



$$I_{22} = \frac{2V}{3k\Omega + [40k\Omega \,||\, (40k\Omega + 20k\Omega)] + 3k\Omega} = \frac{1}{15}\text{ mA}$$

$$I_{12} = I_{22} \times \frac{40k\Omega}{40k\Omega + 20k\Omega + 40k\Omega} = \frac{2}{75}\text{ mA}$$

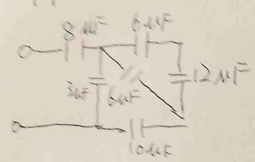
③ total $I_1 = I_{11} + I_{12} = 0.18$ mA

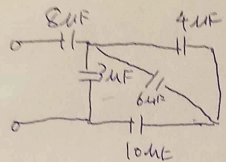
$I_2 = I_{21} + I_{22} = 0.2$ mA

$V_1 = V_A - V_B = -I_2 \cdot 3k\Omega = \cancel{0.6V}\ -0.6V$

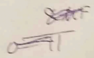
$V_2 = V_C - V_D = I_1 \times 20k\Omega + I_2 \times 3k\Omega - 2V = 2.2V$

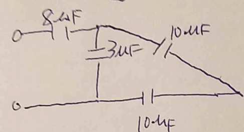
5.17



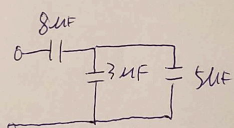


$$\frac{1}{\frac{1}{6}+\frac{1}{12}} = 4(\mu F)$$

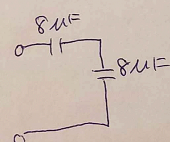




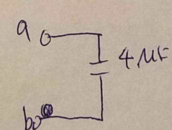
$$6\mu F + 4\mu F = 10\mu F$$



$$\frac{1}{\frac{1}{10}+\frac{1}{10}} = 5(\mu F)$$

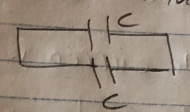


$$3\mu F + 5\mu F = 8\mu F$$

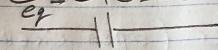


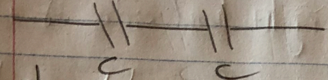
$$\frac{1}{\frac{1}{8}+\frac{1}{8}} = 4\mu F$$

5.18) Observe that :

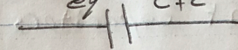


$\equiv$ $C_{eq} = C + C = 2C$

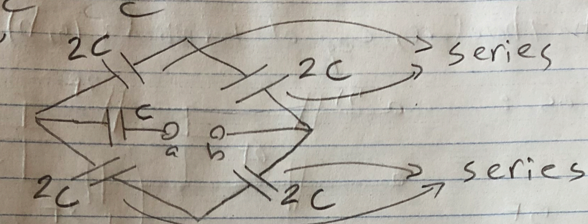




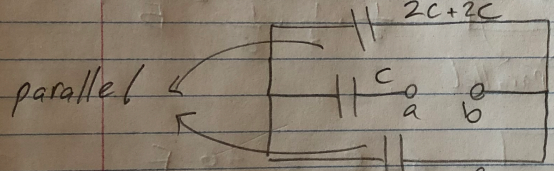
$\equiv$ $C_{eq} = \frac{C \times C}{C + C} = \frac{C^2}{2C} = \frac{C}{2}$



thus,

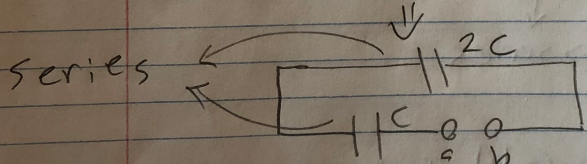


$\Downarrow$ $\frac{2C \times 2C}{2C + 2C} = \frac{4C^2}{4C} = C$

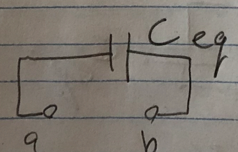


$4C^2/4C = C$

$\Downarrow$

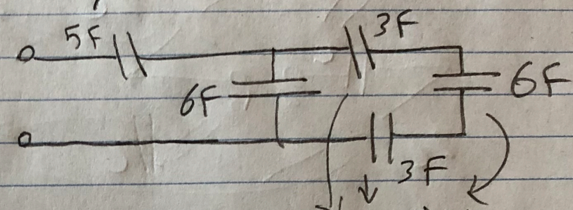


$\Rightarrow$ equivalent capacitor at terminal (a, b) :

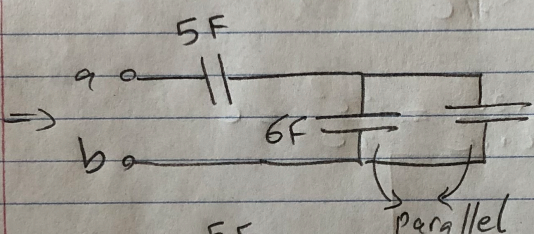


$$\boxed{C_{eq} = \frac{2C \cdot C}{2C + C} = \frac{2C^2}{3C} = \frac{2}{3}C}$$

5.19) As nodes (c) and (d) are not connected to each other (open circuit), thus no curren will flow from 5F capacitors on the right hand side of the circuit. Therefore, C_{eq} at terminals (a, b) can be found as :

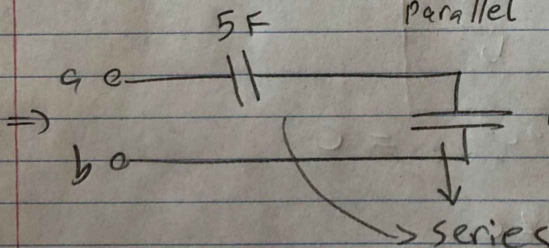


$\Rightarrow$



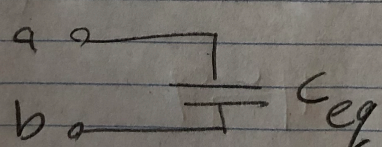
$$\frac{1}{\frac{1}{3}+\frac{1}{3}+\frac{1}{6}} = \frac{6}{5}\,F$$

$\Rightarrow$



$$6+\frac{6}{5} = \frac{36}{5}\,F$$

$\Rightarrow$ C_{eq} at terminals (a, b) is :



$$C_{eq} = \frac{5\times\frac{36}{5}}{5+\frac{36}{5}} = \frac{180}{61} = \boxed{2.95\,F}$$